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(54) Building management system.

(57) A building management system improves the regulation and controls the functioning of appliances (41, 42, 51), such as luminaires, window blinds and heating equipment in a building. The appliances are connected via a communication bus (20) to a control system (10), which performs the automatic regulation and control. To avoid rewiring the bus (20) every time that changes are made to the arrangement of the appliances and/or the lay-out of the building, transponders (40, 50) are mounted at regular fixed places in the building, which transponders transmit bus signals wirelessly to the appliances (41, 42, 51). Additionally the transponders may be provided with a receiver (50a) for two-way communication between appliances and system and for communication between the user and the system using a remote control unit (59).

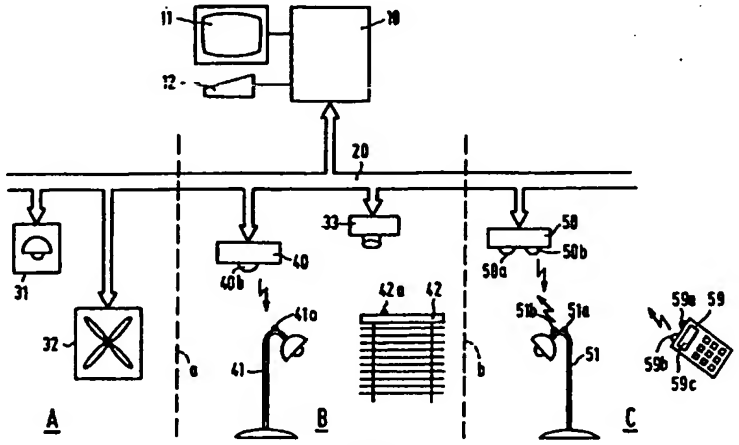

FIG.1

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The invention relates to a building management system, comprising various appliances for building service functions, a control system for control and regulation of said appliances, and a communication bus for communication of signals between the control system and the appliances. Such a system is used for the central management of building functions, such as lighting, heating, ventilation etcetera. Appliances are, for example luminaires, heating equipment, airconditioning devices or electrically movable window blinds. In buildings like offices, commercial and industrial complexes, the central management of energy consuming services allows a relatively easy adjustment of the level of light or temperature to the actual existing demand at any moment. This results in considerable savings of energy and costs. It is also possible with such a system to monitor energy consumption precisely and to charge the users in a multi-user building properly. Further, a building management system can be used for peak shaving purposes in order to comply with requirements by an electricity company for keeping power consumption below an agreed maximum level.

A building management system according to the introductory paragraph is known. An example is described in the brochure "IFS 800 Lighting control system" published by Philips Lighting. In this system each appliance, such as a luminaire, a heating or cooling device or a fan in a space, for example, a room, office or shop area, is coupled with a central control system via a communication bus. In this particular system each appliance is controlled by a local controller unit which is connected to the communication bus and regulated by signals from the central control system. The local controllers comprise the necessary electronics for adjusting several appliances to required levels. An occupant of the space communicates a change of the desired levels to the control system by means of infra-red (IR) signals transmitted by a portable IR remote-control unit to an IR-receiver connected with the communication bus. Further, the known system allows additional determination of the desired levels by means of sensors, such as a presence detector, a thermometer or a light sensor.

Another known building management system, suitable for small complexes such as shops and restaurants, is the BatiBUS/ISIS system, commercialised by the company Merlin Gerin, Meylan, F-38240 France. In this system each appliance comprises its own local controller which is connected with the communication bus. Security and alarms can be incorporated in this known system.

In the known systems the local controllers and the appliances are connected to the communication bus by wires. In a modern office building or commercial complex this is a drawback as spaces are often changed. Changing virtually always requires displacement of the appliances and often also tearing down and rebuilding of internal walls. To achieve a flexible floor lay-out at low cost, a minimum of wiring in the walls is required. However, it is also required by the users of a building to have full control over the location of the appliances, consequently placing appliances on predetermined spots only is unacceptable.

It is, *inter alia*, an object of the present invention to provide a building management system for controlling appliances in a space such as an office or a shop, which system does not need rewiring when appliances are displaced, added to or removed from a space. The system thereby allowing flexible placement of appliances together with a maximum control by the control system.

To this end a system according to the invention is characterised in that at least one appliance comprises a receiver for receiving wirelessly transmitted signals, and in that at least one transponder is coupled with the communication bus for wirelessly transmitting signals to said appliance in response to signals present on the communication bus. The communication or control signals that are emitted by the control system to the appliances are transmitted via the communication bus to a location near the appliance, and from there wirelessly to the appliance. Wiring for the last several meters towards the appliance is not required and the exact position of the appliance, provided it being within reach of the signals transmitted wirelessly by the transponder, is of no relevance to the transmission of these signals. Adding a new piece of equipment in the space, for example a free standing luminaire, does not need an extension of the communication bus to that new piece of equipment for incorporating it in the system.

The transponder may be suitable for one particular appliance only or for one type of appliances, but preferably it is constructed to transmit signals for all kinds of appliances to be used within the framework of a building management system. Transponders can be fixedly arranged at regular distances inside a building, for example in the ceilings, and no wiring changes are needed when the internal lay-out of the building is changed. Several appliances can be reached simultaneously and served by signals from one transponder.

An embodiment of a system according to the invention is characterised in that the transponder comprises a transmitter for generating signals for wireless transmission and a processor for conversion of signals received via the communication bus into a format suitable for wireless transmission, wherein the processor is arranged for holding back signals which are not meaningful for the appliances to be reached by wireless transmission of signals

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EUROPEAN SEARCH REPORT

Application Number

EP 91 20 1071

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	EP-A-0 361 585 (MATSUSHITA ELECTRIC WORKS, LTD.) * column 1, line 1 - line 15 * * column 4, line 10 - line 50; figure 1 *	1-8,10, 11	H04Q9/00 G08C23/00
Y A	DE-A-3 232 015 (SIEMENS AG) * the whole document *	1-8,10, 11 9	
Y	WO-A-8 911 137 (VOGEL) * claim 1; figure 1 *	2,5	
Y	PATENT ABSTRACTS OF JAPAN vol. 10, no. 79 (E-391)(2136) 28 March 1986 & JP-A-60 224 394 (MATSUSHITA DENKO K.K.) 8 November 1985 * abstract *	4	
Y,D	GB-A-2 166 328 (INTERNATIONAL STANDARD ELECTRIC CORPORATION) * page 1, line 103 - page 2, line 119; figures 1,2 *	8	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	REVUE GENERALE DE L'ELECTRICITE, no. 2, February 1989, PARIS FR page 86; 'Système de controle du batiment' * the whole document *	1	G08C H04Q G06F G08C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	08 JANUARY 1992	WANZEELE R.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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transmitted by said transmitter and the minimum power for activation of the receiver is at least of the order of magnitude of 10^8. In order to allow maximum flexibility in changing the lay-out of a building, the transponder preferably is not to be arranged in walls. Internal walls should be removable as easy as possible, while external walls may be too far away from the appliances in a building with a certain depth. Therefore, the preferred place for a transponder is in the ceiling. As the receiver in an appliance should be reached also by a remote control unit held at about one meter above the floor anywhere in the space, the orientation of the receiver cannot be optimised for receiving signals from the direction of the transponder. In this embodiment the transmitter in the transponder emits a signal sufficiently strong that even after reflection at surfaces of equipment or at the walls the signal is successfully transmitted. The indicated ratio allows a transmission path with a length of about 6 meters with a 90% energy loss due to reflections. It was found that this is sufficient for a conventional office environment.

These and other, more detailed, aspects of the invention will be apparent from and elucidated with reference to the drawings and embodiments described hereinafter.

The drawings show in

Figure 1 diagrammatically an embodiment of a building management system in accordance with the invention;

Figures 2a and 2b a transponder in accordance with the invention.

In Figure 1 a building management system according to the invention is diagrammatically shown. The system comprises a control system 10, shown as a single processor such as a personal computer or a dedicated processor. Alternatively, the control system 10 may comprise several distributed processors linked together, some of these may be dedicated to specific tasks. For programming purposes and for entering and obtaining information about the system, the control system may have peripherals such as a display 11 and a keyboard 12. The control system is connected to a communication bus 20. The communication bus 20 is linked to various devices, shown are two appliances 31 and 32, for example a luminaire and a fan, and a sensor 33, for example a light sensor. The communication bus 20 is further connected to two transponders 40 and 50. The various devices may be placed in different spaces, as indicated by dashed lines a and b indicating walls between rooms A, B and C. In the rooms B and C, in which transponders 40 and 50 are placed, several further appliances 41, 42 and 51 are shown. As an example, appliances 41 and 51 are shown as luminaires and appliance 42 is represented as a set of window blinds.

The appliances are regulated by signals emitted by the control system 10, in accordance to instructions entered in there. Normally the instructions will be comprised in a program which runs continuously in a processor of the control system and generates signals in response to information from sensors and build-in equipment such as a clock and a calender. Exceptionally, the signals may be generated by commands given by an operator to the control system via the keyboard 12. The signals are communicated to the appliances and other devices via the communication bus 20. Each device connected to the bus receives all the signals. As signals comprise address information, *i.e.* information identifying the destination, only the device or devices for which a signal is intended will react to the signal.

Extending the communication bus 20 to all appliances and sensors in a building is costly, in particular when appliances are moved, removed or added, because then changes have to be made to the wiring of the communication bus 20. This is the case even more when the internal lay-out of the building changes, for example when walls are removed and/or rearranged. To avoid this, in the building management system according to the invention transponders 40 and 50 are connected to the communication bus 20. The transponders 40 and 50 receive the signals from the communication bus 20, convert those signals into a wirelessly transmittible form and send them towards the appliances 41, 42 and 51 which are equipped with receivers 41a, 42a and 51a, respectively, to detect the signals.

Preferably the transmission between the transponders and the appliances uses infra-red signals (IR). As this does not penetrate walls the signals are confined to one room. However, other ways for wireless transmission, such as ultrasone or radio-frequency transmission may be used as well.

The first transponder 40 shown in Figure 1 comprises several infra-red light emitting diodes (IR-LEDs), forming an IR-transmitter 40b, for transmitting IR signals more or less uniformly in the room B. Both appliances 41 and 42 receive all transmitted signals, via IR-receivers 41a and 42a, respectively. The transponder 40 may convert all signals on the communication bus to IR-signals emitted into the space. However, as only a fraction of the signals is intended for the appliances 41 and 42 a better way of operating the transponder is to select these signals in the transponder 40 and to retransmit only the ones relevant for the appliances 41 and 42 in the room B.

The second transponder 50 in room C comprises, in addition to an IR-transmitter 50b, an IR-receiver 50a. The appliance 51 comprises an IR-

receiver 51a and a IR-transmitter 51b. When a signal is received by the receiver 51a of the appliance 51, a return signal is transmitted from the appliance 51 to the transponder. This signal may be an acknowledgement that the initial signal has been received correctly or it may contain status information about the appliance's status when the initial signal requested such information. When the appliance 51 is a luminaire which can be dimmed, such status information may be the dimming level.

In addition to signals from the control system 10, a user in the space can overrule the setting of an appliance by using a remote control unit 59. In response to commands given by the user the remote control unit emits signals which are received by the receiver 51a of the appliance 51. In order to signal to the building management system the changed status of the appliance various possibilities exist. Firstly, the appliance can emit, via its transmitter 51b, a signal to the receiver 50a of the transponder 50 that its status has changed or, secondly, the control system 10 can interrogate at regular intervals the status of each appliance for its present status. As a third possibility the transponder 50 can do the interrogation at regular intervals and transmit the status of the appliance 51 only when the appliance's status has changed.

The remote control unit 59 is optionally provided with an IR-receiver 59a and a display 59c or any other device for communication to a human operator. Two-way communication between the occupant of the space and the system is herewith provided.

As identical equipment may be present in other rooms of the same building, and as these other pieces of equipment are regulated by the same control system, each piece of equipment must have a unique address. To avoid the subsequent large number of different addresses to be set in the appliances, and to allow easy interchangeability between pieces of equipment, each transponder in the system is provided with a unique address of itself and passes only signals to the appliances within its reach when the signal on the communication bus 20 comprises this transponder's address. The address in a signal sent by the control system 10 on the communication bus 20 then comprises both a unique transponder address and a, not unique, appliance address. Moving an appliance from one space to another or, what is equivalent, from one transponder to another, means that no change in the equipment is to be made. Only the system, *i.c.* the transponders and the control system 10, have to be informed, preferably the information is shared via the communication bus 20.

Figures 2a and 2b show diagrammatically a transponder 50 for use in a building management system according to the invention. The transponder in Figure 2a contains a processor 52 for conversion of the signals on the communication bus 20 to IR signals that can be transmitted via transmitter 50b, shown as a block of IR-LEDs. For example, the processor is a microprocessor of the type Intel 8051. A pair of terminals 53a and 53b connects the microprocessor with the communication bus 20. If required, the transponder is provided with an interface, not shown, to convert electrical signals such as voltage levels occurring at the communication bus to electrical signals required at the input of the microprocessor.

The transponder further comprises power supply terminals 54a and 54b for connection of a power supply unit 54 to a power line 25, for example the mains. As the block of IR-LEDs may consume quite a lot of power to generate sufficiently strong IR-signals for reaching faraway or partly hidden receivers that make reflection necessary, supply by an internal source such as a battery, or via the communication bus may not provide sufficient power. The total optical power to be generated to ensure successful operation in an office environment is in the order of magnitude of one Watt. The electrical power needed to generate that optical power is twenty to forty times that value, to be consumed during transmission.

In between the processor 52 and the block of IR-LEDs 50b, an interface-unit 55 is arranged to provide the block of IR-LEDs 50b with sufficient power in response to the output signals generated by the processor 52. For maintenance purposes an additional LED 56 is included parallel to the block of IR-LEDs 50b. The additional LED 56 emits light in the visible range and is to be used to easily obtain information whether the block of IR-LEDs 50b is activated. In front of the block of IR-LEDs 50b an optical system, not shown, may be arranged to disperse the radiation emitted by the transmitter 50b in the space.

The transponder 50, as shown in the Figure, is provided with an IR-receiver 50a coupled with the processor 52.

In Figure 2b a functional diagram of an embodiment of the transponder 50 is shown. The kernel of the transponder is a microprocessor 60 which selects incoming messages, and decides whether to convert them into another format and to retransmit them. For this purpose the microprocessor 60 is provided with, or connected to, a read-only memory 61 with a computer program loaded into it and/or a programmable memory 62 for storing modifiable data about the system, such as the appliances served by this transponder. The processor further comprises an interface 63 to the communication bus 20, an IR-transmitter 64 and an IR-receiver 65. The indicated bus interface 63 is a functional unit and may be a part of a program

running in the microprocessor 60.

A message entering via the communication bus 20 is checked for its integrity and destiny in the bus interface 63. When the message on the communication bus is intended for this transponder or an appliance served by this transponder, the bus interface 63 will return an acknowledge signal on the communication bus. If a message on the communication bus is incomprehensible or has not this transponder as a destination, no acknowledgement is returned by the bus-interface. An accepted message is passed to the microprocessor 60, and processed there. When the message is intended for one of the appliances served by the transponder, the message is converted into the proper IR transmission format and transmitted via the transmitter 64. In addition to messages for the appliances, a message could be used for modifying the internal settings of the transponder, for example signalling that an appliance is added or removed from the set served by this transponder. In that case the message causes the contents of the programmable memory 62 to be updated.

In a further development of the system, the transponder may comprise a IR-receiver 65. This receiver can be used, for example, for receiving acknowledge signals from the appliances. Absent an acknowledge signal within a predetermined interval, the microprocessor will retransmit the last message via the transmitter 64. After a preset number of trials, an error message can be transferred via the communication bus to a central control system. Another use of the receiver 65 is to provide communication between a IR remote control unit and the transponder and, via the communication bus 20, the building management system. The transponder, or the system, is then programmable using a, special, remote control unit.

Certain messages, received by the IR-receiver 65 and not intended for the transponder or the system, but for the appliances served, can be retransmitted after a few milliseconds via the IR-transmitter 64. It is then ensured that the appliances will receive sufficiently powerful signals, even when the signal from a remote control unit is weak. As is the case with messages received from the communication bus, the transponder may filter or modify messages received via the receiver 65 before retransmission via the transmitter 64. This allows, for example, the use of the same or a similar remote control unit in different rooms or in different situations for different appliances. An "up" or "down" signal received by the transponder is then to be transmitted as an "up" or "down" signal for window blinds or for lamps, depending on the equipment around, the light level, the time of day, or any other relevant parameter.

A building management system according to the invention can be extended or complemented with other devices communicating with the control system and the transponders via the bus. Such other devices are, for example, sensors, such as a light sensor and/or a presence detector, which signal that a space should become illuminated. Via the bus the transponder then "knows" which appliances should be turned on via transmission of IR-signals. Another example is a local control unit for checking the use and performance of the appliances served by a group of several transponders. Sensors and control units can be constructionally integrated with a transponder.

Claims

1. Building management system, comprising various appliances for building service functions, a control system for control and regulation of said appliances, and a communication bus for communication of signals between the control system and the appliances, characterised in that at least one appliance comprises a receiver for receiving wirelessly transmitted signals, and in that at least one transponder is coupled with the communication bus for wirelessly transmitting signals to said appliance in response to signals present on the communication bus.

2. Building management system according to Claim 1, characterised in that the transponder comprises a transmitter for generating signals for wireless transmission and a processor for conversion of signals received via the communication bus into a format suitable for wireless transmission, wherein the processor is arranged for holding back signals which are not meaningful for the appliances to be reached by wireless transmission of signals via said transponder.

3. Building management system according to Claim 1 or 2, characterised in that at least one appliance is provided with a transmitter for wireless transmission of signals, and in that the transponder comprises a receiver for receiving wirelessly transmitted signals.

4. Building management system according to Claim 3, characterised in that the at least one appliance comprises means for transmitting an acknowledgement signal after receipt of a signal from the transponder and in that the transponder comprises means for repeating the previously transmitted signal when no acknowledge signal is received.

5. Building management system according to any one of the preceding Claims, characterised in that the system further comprises a portable remote control unit for wireless transmission of signals to the appliances.

6. Building management system according to Claim 5, characterised in that the transponder comprises a receiver for receiving signals wirelessly transmitted by the remote control unit and in that the transponder comprises means for retransmission of a signal received from the remote control unit, via the communication bus or via the transponder's wireless transmitter.

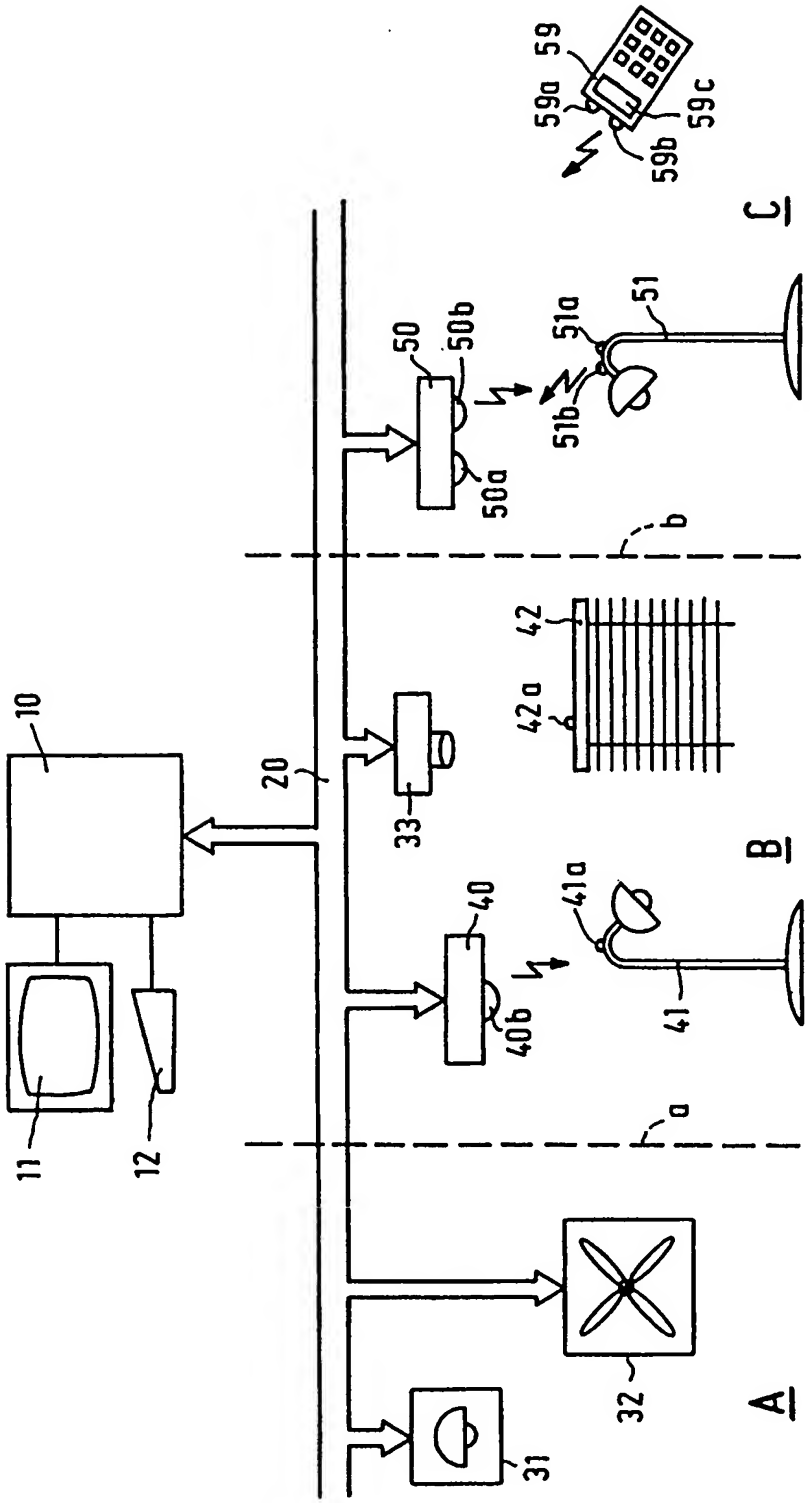
7. Building management system according to Claim 6, characterised in that the transponder comprises means for filtering and modification of a signal received from the remote control unit prior to retransmission thereof.

8. Building management system according to Claim 5, characterized in that the remote control unit is provided with a receiver for receiving signals wirelessly transmitted by the transponder and display means for displaying thereupon messages transmitted by said signals.

9. Building management system according to any one of the preceding Claims, characterised in that a transponder comprises an infra-red transmitter, in that an appliance comprises an infra-red receiver and in that the ratio between the power of infra-red signals transmitted by said transmitter and the minimum power for activation of the receiver is at least of the order of magnitude of 10^8.

10. Transponder, suitable for use in a building management system according to one of the preceding claims, comprising data terminals for connection to a communication bus, a transmitter for generating signals for wireless transmission and a processor for conversion of signals received via the data terminals into a format suitable for wireless transmission, wherein the processor is arranged for conversion of a selected set of signals only.

11. Appliance, suitable for use in a building management system according to Claim 3 or 4 and comprising a transmitter for wireless transmission of signals.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59b
59c
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51b
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50b
50a
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FIG.1

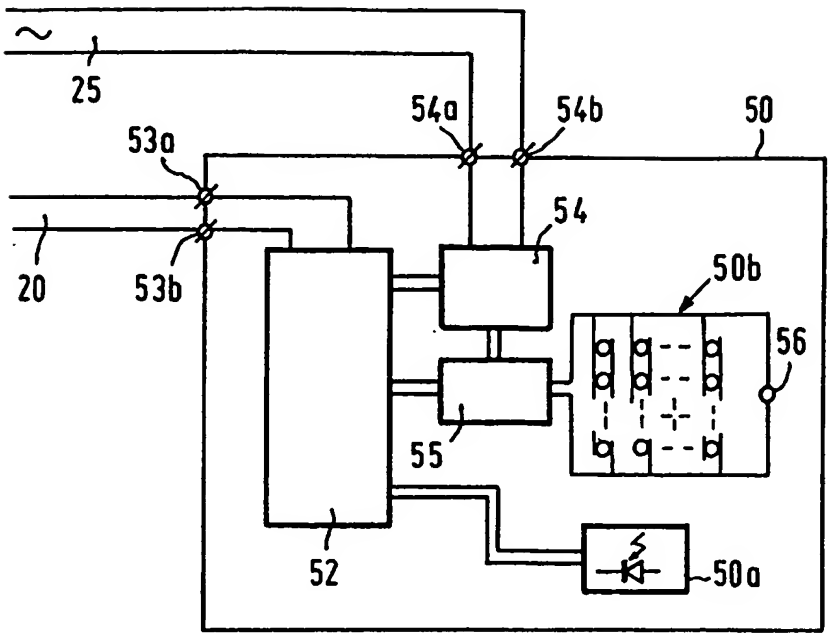

FIG.2a

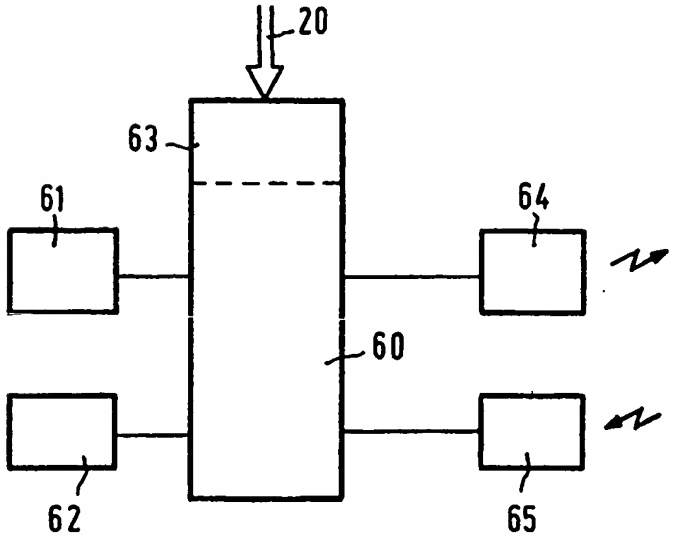

FIG.2b

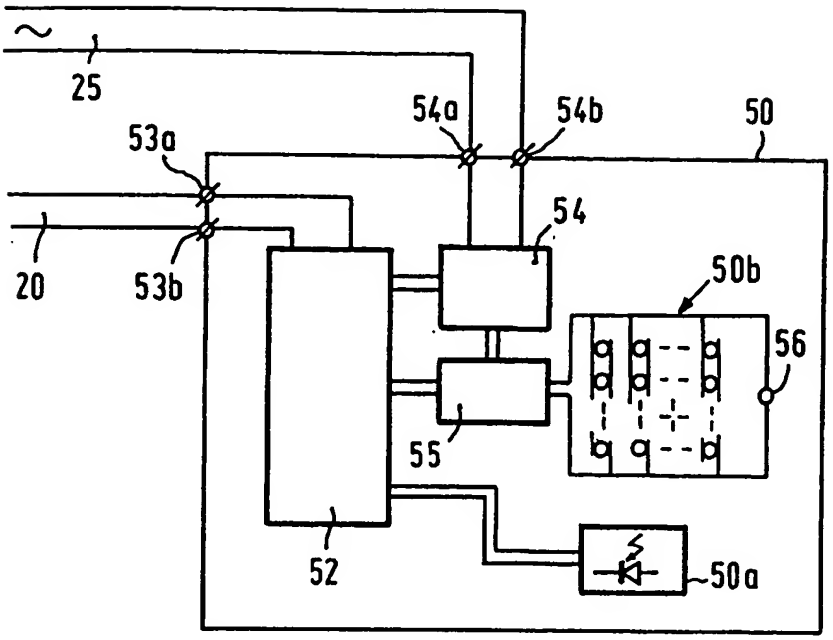

FIG.2a

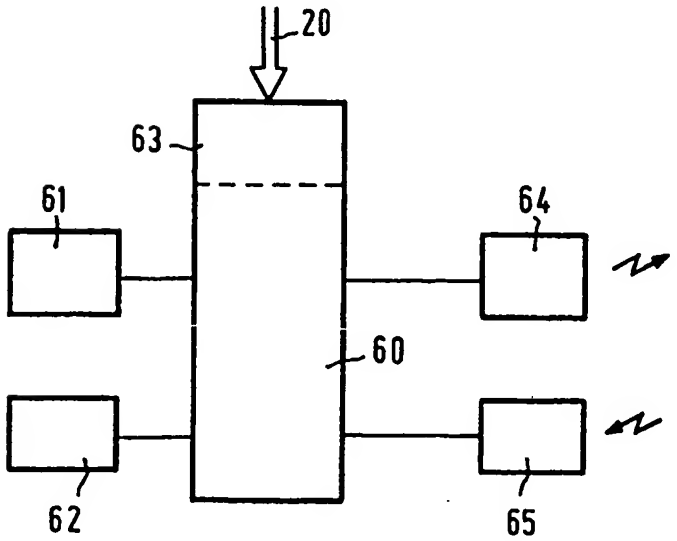

FIG.2b

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EUROPEAN SEARCH REPORT

Application Number

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	EP-A-0 361 585 (MATSUSHITA ELECTRIC WORKS, LTD.) * column 1, line 1 - line 15 * * column 4, line 10 - line 50; figure 1 *	1-8, 10, 11	H04Q9/00 G08C23/00
Y A	DE-A-3 232 015 (SIEMENS AG) * the whole document *	1-8, 10, 11 9	
Y	WO-A-8 911 137 (VOGEL) * claim 1; figure 1 *	2,5	
Y	PATENT ABSTRACTS OF JAPAN vol. 10, no. 79 (E-391)(2136) 28 March 1986 & JP-A-60 224 394 (MATSUSHITA DENKO K.K.) 8 November 1985 * abstract *	4	
Y,D	GB-A-2 166 328 (INTERNATIONAL STANDARD ELECTRIC CORPORATION) * page 1, line 103 - page 2, line 119; figures 1,2 *	8	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	REVUE GENERALE DE L'ELECTRICITE, no. 2, February 1989, PARIS FR page 86; 'Système de controle du batiment' * the whole document *	1	G08C H04Q G06F G08C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	08 JANUARY 1992	WANZEELE R.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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